Knowing Asian aquaculture and fisheries

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MALAYSIA

Fish supply for consumption in Malaysia is mostly from marine capture fisheries, but they also come from inland water bodies such as rivers, lakes, reservoirs, irrigation canals, and paddy fields.

Aquaculture production in 1995 was 132,742 tons valued at RM 392.67 million excluding ornamental fish. These figures show increases of 16.3% and 7.6% respectively over the previous years, showing that aquaculture production is still small and contributes only 11% to national fish output of 1,242,177 tons valued at RM 392.669 million.

Utilization of labor is also still insignificant, involving only about 17,851 fish farmers in 1995, more than 90% of which were small-scale fishfarmers. Total pond surface area utilized for aquaculture in 1995 was 9,144 ha, of which about 70% were freshwater ponds. In addition, a total of 795,785 m^2 of cage surface was utilized, of which 90% were marine fish cages. A total of 61,196 m^2 of tank surface were also used in the same year.

Aquaculture practices

Culture of cockles. Cockle culture is the mainstay of Malaysian aquaculture. More than 70% of aquaculture production comes from the on-bottom culture of the cockle *Anadara granosa*. In 1995, about 100,276 tons valued at RM 39.4 million were produced from mudflats located mainly off the west coast of Peninsular Malaysia. This production comes from 4,753 hectares of culture bed.

The cockle seeds are collected from natural cockle spatfall areas and not hatchery-produced. Cockle thrive well on coastal mudflats, in salinity of 18-30 ppt. These are sedentary and feed on microscopic plants or phytoplankton in the intertidal zone, and hence require very little effort in the culture operations.

The culture densities very much depend on spat sizes. Optimum production size is usually attained after over a year of culture. Average production in 1995 was 21 tons per ha per year.

Freshwater fish culture. The second greatest contributor to aquaculture production is freshwater fish culture. It is implemented mainly in abandoned mining pools, excavated ponds, and pens or cages. In 1995, there were 27,410 excavated ponds (5,367 hectares), 271 abandoned mining pools (1,156 ha), 892 pens and 4,110 cages (79,633 m^2).

In 1995, 18,493.2 tons of freshwater fish valued at RM 130 million was produced. Culture of eel, *Anguilla japonica*, remained the largest single contributor. The second largest was tilapia (mainly *Oreochromis niloticus* and the red hybrids), followed by Javanese carp *Puntius gonionotus*, the common carp *Cyprinus carpio*, and the African catfish *Clarias gariepninus* and its hybrids.

The other freshwater species being cultured include the grass carp *Ctenopharyngodon idella*, bighead carp *Aristhichthys nobilis*, river catfish *Mystus nemurus*, snake skin gourami *Trichogater pectoralis*, and the giant Malaysian prawn *Macrobrachium rosenbergii*. Substantial amounts of other fish are river catfish *Pangasius sutchi*, Indian carp *Labio rohita*, river carp *Leptobarbus hoevenii*, and marble goby *Oxyeleotris marmoratus*.

Efforts are also being taken to develop the breeding and culture technologies for the indigenous species such as *Tor tambroides*, *Probarbus julleini*, and *Puntius bulu*.

Ornamental fish culture. Breeding and culture of ornamental fish gained popularity in the 80's and has undergone rapid development since then. Over 150 varieties of fish were produced mostly for export.

The gold fish and koi carp are the largest production (45.4%), followed by barbs and danios (26.7%), and poecilids (17.9%). In 1995, there were 253 million ornamental fishes valued at RM 49.13 million.

Marine cage culture. Culture of marine fishes in floating cages has undergone rapid development since its introduction in the early 70's. It now ranks third in the local aquaculture industry. Until the end of 1995, there were 64,262 cages (715,152m^2) in Malaysia. These cages produced 5,762 tons valued at RM 85 million in 1995.

The seabass *Lates calcarifer* remains the main species being cultured, constituting about 80% of total output. Other species are the grouper *Epinephelus* spp., the mangrove snapper *Lutjanus* spp., and lately golden pomfret *Trachinotus blochii*.

PHILIPPINES

The Philippines ranks 12th among the largest fish producers in the world in 1994, contributing 2.3 million tons of fish or 2.1% of the total world catch of 110 million tons (FAO Yearbook 1994). It is the second biggest producer of tuna and tuna-like fishes

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in the Indian Ocean and Southeast Asian Region in 1991 with Indonesia and Thailand as the first and third biggest producers, respectively. It is the third biggest producer of seaweeds and other aquatic plants, contributing 5.2% (0.405 million tons) in the world production of 7,839 million tons in 1994). Table 1 shows the fisheries resources of the Philippines.

In 1996, the fisheries industry's contribution to the country's Gross Domestic Products (GDP) of ₱2,189.8 billion at current prices and ₱846.9 billion at constant prices were 3.5% (₱76.2B) and 3.9% (₱32.9B), respectively.

TABLE 1 Fisheries resources of the Philippines (Philippine Fisheries Profile 1996)

Category	Area	Notes
MARINE RESOURCES		
Total territorial waters	220,000,000 ha	(including EEZ)
Coastal	26,600,000 ha	12% of the total
Oceanic	193,400,000 ha	88% of the total
Shelf area (200 m deep)	18,460,000 ha	8% of the total
Coral reefs (within 10-20 fathoms)	27,000 sq km	
Coastline (length)	17,460 km	
INLAND RESOURCES		
Swamplands	338,393 ha	
Freshwater	106,328 ha	
Brackishwater	232,065 ha	
Existing fishponds	253,854 ha	
Freshwater	14,532 ha	
Brackishwater	239,323 ha	
Other inland resources	250,000 ha	
Lakes	200,000 ha	
Rivers	31,000 ha	
Reservoirs	19,000 ha	

Status and practices of coastal aquaculture

The total fish production in the Philippines in 1996 was 2,769,178 tons, 32.8% of which came from municipal or sustenance fishing, 31.7% from offshore or commercial fishing, and 35.4% from aquaculture.

The present fish production from the coastal zone decreased and the fish caught were of lower commercial value. Commercial fishing decreased in production and existing fishing boats are old and small and lacks modern equipments to explore the Exclusive Economic Zone. Table 2 shows the slight yearly increase in production from 1987 to 1996.

In terms of value, aquaculture contributed 40% of the ₱83.1 billion fish production in 1996. Table 3 shows the production from brackishwater ponds, freshwater ponds, pens and cages, and mariculture.

In the export markets, cultured shrimps which for quite sometime has been occupying the number one slot was replaced by tuna. In 1996, shrimp export dropped from a high of 18,257 million tons (₱0.653 B) in 1995 to 13,514 million tons (₱0.399 B) in 1996. Shrimp continue to suffer significant setbacks, declining by 26% and 29% in volume and value respectively as a result of disease outbreaks which affected Western Visayas in particular.

TABLE 2 Fish production by sector, 1987-1996 (in tons) (Philippine Fisheries Profile 1996)

Year	Aquaculture	Municipal	Commercial	Total
1996	980,857	909,248	879,073	2,769,178
1995	919,039	972,043	893,232	2,784,314
1994	791,444	1,009,738	885,446	2,686,628
1993	772,082	1,030,274	845,431	2,647,787
1992	736,381	1,084,360	804,866	2,625,607
1991	692,401	1,146,765	759,815	2,598,981
1990	671,116	1,131,866	700,564	2,503,546
1989	629,345	1,104,626	637,138	2,371,109
1988	599,554	1,070,195	599,995	2,269,744
1987	560,670	1,060,878	591,192	2,213,040

Brackishwater aquaculture

Brackishwater ponds range from small and simple impoundments to huge excavations of complex engineering design. Most ponds are built on what used to be mangrove swamps. Estimates of mangrove areas converted to fishponds during 1950-1973 range from 1,000 to 24,000 hectares per year. Some 239,323 hectares of brackishwater fishponds are in existence as of 1996. About 176,000 hectares are used for milkfish culture and the rest are for production of tiger shrimp and other species. A total of 314,343 tons were produced from brackishwater ponds in 1992: 228,358 tons milkfish; 59,657 tons shrimp; and 26,328 tons other species (BFAR 1992). In 1995, it was reduced to 237,056 tons, with milkfish at 137,796 tons but tiger shrimp or prawn increased to 90,110 tons (BFAR 1996).

In 1982, when there was demand for tiger shrimp in the world market, many pond operators switched to shrimp production. The availability of commercial feeds and shrimp farming technology and intensive research in shrimp biology and hatchery techniques led to the rapid take-off of the shrimp industry. Milkfish ponds and even sugarlands were converted into shrimp farms, many of them intensive systems. The use of feeds and life support systems allowed high stocking densities. In areas where the Taiwanese method was not feasible, the extensive and semi-intensive sys-

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and transported to a hatchery for further incubation and hatching. The effects of varying periods of simulated transport (mobile or stationary periods) were also examined. At C-shaped embryo stage, neither mechanical shock (*F*, 13-127 erg per egg) nor prolonged shaking (3-9 h) simulating mobile periods of egg transport affected hatching rate, larval mortality, and incidence of deformed larvae. Exposure to still water (unshaken) simulating stationary periods of egg transport, however, tended to lower hatching rate and significantly increased the incidence of deformed larvae and the combined mortalities and deformed larvae. These results indicate that the sensitivity of milkfish eggs to mechanical shock varies during incubation and that C-shaped embryos may be manipulated or transported with minimum risk of injury. Some recommendations are given regarding proper handling and transport of fertilized eggs.

Table 3 Aquaculture production (in million tons) by type of culture and region, 1996 (BFAR)

Region	Total	Brackish-water ponds	Fresh-water ponds	Fresh-water pens	Marine fish cages	Marine fish pens
NCR	4,854	4,722	0	0	127	5
CAR	993	0	288	0	705	0
I	25,820	18,993	2,060	9	11	4,747
II	1,765	507	1,128	0	124	6
III	101,998	63,399	36,277	30	130	2,162
IV	216,063	13,691	1,015	16,235	16,717	168,405
V	22,282	2,493	49	3	10,321	9,416
VI	86,355	65,588	928	0	6	19,833
VII	40,573	14,100	7	0	0	26,466
VIII	4,369	1,906	45	0	5	2,413
IX	106,423	12,286	65	23	2	94,047
X	2,252	2,027	180	0	2	43
XI	19,243	14,239	1,223	2	3,258	521
XII	7,355	6,961	378	0	0	16
XIII	3,860	3,387	13	1	9	450
ARMM	336,652	952	20	5	15	335,660
TOTAL	980,857	225,251	43,676	16,306	31,432	664,190

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tems were adopted. Thus, tiger shrimp production increased from 1,805 tons in 1982 to 59,657 tons in 1992 and 90,456 tons in 1995.

In 1992, some 26,328 tons of groupers, siganids, spadefish, sea bass, and muderabs were produced (BFAR). The muderab *Scylla serrata* is also in demand in local markets. Small-scale fish farmers buy or collect lean crabs and fatten them in cages or ponds divided into compartments by nets or split bamboo. The crabs are fed trash fish and harvested after 15 days or more.

Freshwater aquaculture

The production from freshwater ponds, pens and cages in 1992 of nearly 98,000 tons, mostly came from central, southern, and southeastern Luzon.

Freshwater fish culture had a rapid development in the Philippines in 1972 when the tilapia *Oreochromis niloticus* was introduced. Now, the species is well established throughout the Philippines in lakes, rivers, reservoirs and fishponds. *O. niloticus* is cultured in about 14,531 hectares of ponds and over 5,000 hectares of cages. Tilapia production in 1992 was 40,399 tons from ponds, 24,871 tons from cages, and 4,917 tons from pens (BFAR 1992). Tilapia cage culture is expanding to many lakes and reservoirs in the country and production is expected to increase.

The Bureau of Fisheries Aquatic Resources (BFAR) collaborated with the International Center for Living Aquatic Resources Management and the Central Luzon State University Freshwater Aquaculture Center on a study funded by UNDP-FAO on tilapia genetic improvement in 1989-1992. This collaboration yielded the so-called GIFT (genetically-improved farmed tilapia). Test culture of GIFT under different farming systems showed that it grows 60% faster than the ordinary *O. niloticus* used by farmers.

In Sampaloc Lake in Laguna, however, intensive tilapia cage culture with heavy feeding has resulted in eutrophication, oxygen depletion, and mass kills of cultured stocks (Santiago and Arcilla 1993).

Milkfish, carps, catfishes. Milkfish is grown in about 18,000 hectares of pens in Laguna de Bay and 21,511 tons were produced in 1992 (BFAR 1992). Pollution, multi-use conflicts, and fish kill continue to be the major problems for the milkfish and tilapia industry in Laguna de Bay.

The production of carps, including the big head carp *Aristichthys nobilis* and common carp *Cyprinus carpio*, from ponds and cages amounted to 4,615 tons in 1992 (BFAR 1992). The upgrading of carp species in the country is also being done by BFAR. Pure strains of common carps *Cyprinus carpio* were imported in May 1994 from Sukabumi (West Java) and from Madjalaya and are now being grown into breeders at BFAR in Tanay, Rizal.

The native catfish *Clarias macrocephalus* is becoming rare in the Philippines, probably due to loss of appropriate habitats and increasing pollution. Culture of the Thai catfish *Clarias batrachus* is well established in the country. In 1990-1992, some farmers started the culture of the African giant catfish *C. gariepinus*.

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Table 4 **Production from mariculture, 1995 (in tons) (BFAR 1996)**

Region	Total	Oyster	Mussel	Seaweeds
NCR	267	0	267	0
CAR	0	0	0	0
I	5,518	5,518	0	0
II	2	2	0	0
III	2,115	2,115	0	0
IV	3,077	563	803	1,711
V	12,279	19	1,447	10,813
VI	13,500	3,381	8,842	1,277
VII	20,211	63	2	20,146
VIII	1,977	0	1,917	60
IX	87,579	174	3	87,402
X	42	0	0	42
XI	480	39	0	441
XII	22	0	a/	22
XIII	391	0	0	391
ARMM	343,749	0	0	343,749
Total	491,209	11,874	13,281	466,054

[a]Quantify less than 1 ton.

Mariculture

The oysters *Crassostrea iredalei, C. malabonensis* and *C. cuculata* have been cultured for a long time and the green mussel *Perna viridis* since 1950. All the harvest, about 25,000 tons in 1995, are marketed locally.

Seaweeds. Mariculture of the seaweeds *Eucheuma* is now a well established industry that produced 466,054 tons in 1995 (Table 4). Most *Eucheuma* farms are in central Visayas and Mindanao. Locally based seaweed processing plants are capable of producing refined and semi-refined forms of carageenan that are used in many commercial products. *Eucheuma* farming and processing is a lucrative industry and *Eucheuma* ranks third among the country's fishery exports.

The pond culture of *Gracilaria* for agar extraction is beginning to take off. BFAR is implementing a UNDP-FAO project to develop farming and processing technologies for *Gracilaria* species and to train government technicians and the families of coastal fishers (Taw 1994). The project area covers coastal towns in eastern Sorsogon and Sorsogon Bay. Taxonomic studies identified 11 species of *Gracilaria* from Sorsogon Bay, five of which have good potential for farming because of their fast growth rate and good quality agar.

Groupers. Grouper culture in floating net cages has been started in recent years but juveniles are insufficient. Among the existing grouper cage culture projects are those of the Palawan National Agricultural College, National Fisheries Research and Development Center in Pangasinan and Atlas Corporation in Bohol. Juvenile groupers are bought from fishers and reared in net cages to marketable size or to become breeders. Unless hatchery-reared juveniles become available however, the grow-out culture of groupers still remain small-scale.

THAILAND

Fisheries production in Thailand is derived from both inland and marine resources. Inland fisheries production comes from the freshwater fishing and aquaculture which is practiced throughout the country. Inland fisheries production is low and does not change much when compared to marine fisheries production. Marine fisheries comes from capture both within and outside the EEZs of Thailand and coastal aquaculture production.

Thailand has a large suitable area for coastal aquaculture, approximately 2,600 km of shoreline. For coastal aquaculture activities, they have been zoned from the coastal land down to the intertidal zone. The most important coastal aquaculture species are black tiger shrimp, grouper, seabass and shellfishes (oyster, blood cockle, and green mussel). In 1993, Thailand shrimp farming produced about 225,514 tons from 71,887 ha of culture area. Fish production was estimated at about 3,502 tons for cultured area of 320 ha. And production of oyster, blood cockle, and green mussel were about 17,811 tons, 20,577 tons and 24,391 tons, respectively. Coastal aquaculture products are important for local consumption and export.

Prior to 1960, marine fisheries in Thailand consisted mainly of small-scale fisheries. With the introduction of mechanized bottom trawling using the otter board trawl for demersal fishes in the Gulf of Thailand during 1960s, the average annual marine production rose significantly from 146,000 tons to approximately 1.5 million tons in 1973. Soon after, it became evident that they were reaching the maximum limits of exploitation. Now, more than 30% of catch is composed of trash fish.

In the mid-'80s, the focus of fishing has shifted to the pelagic fish resources, increasing marine production year by year to the present level of 2,752,500 tons (since 1993). The number of registered fishing vessels for pelagic species has showed the trend to be increasing. Recently, pelagic fishes have also contributed a high percentage in the top ten groups of marine catches.

In 1993, the marine fisheries production accounted for 82.73% of the total fisheries production. The marine landing was composed of food fish, 45.01%; shrimp, 11.31%; shellfish, 4.4%; cephalopods, 5.03%; crabs, 1.54%; others, 0.51%; and trash fish 33.68%. Production from small-scale fisheries comprised about 17.8% by volume and 28.6% by value of the total marine capture fisheries.

The main identifiable problem facing coastal aquaculture is that 55% of total mangrove area has been destroyed. The main man-

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Fisheries production in quantity by sub-sectors 1979-1993 (x 1,000 tons)

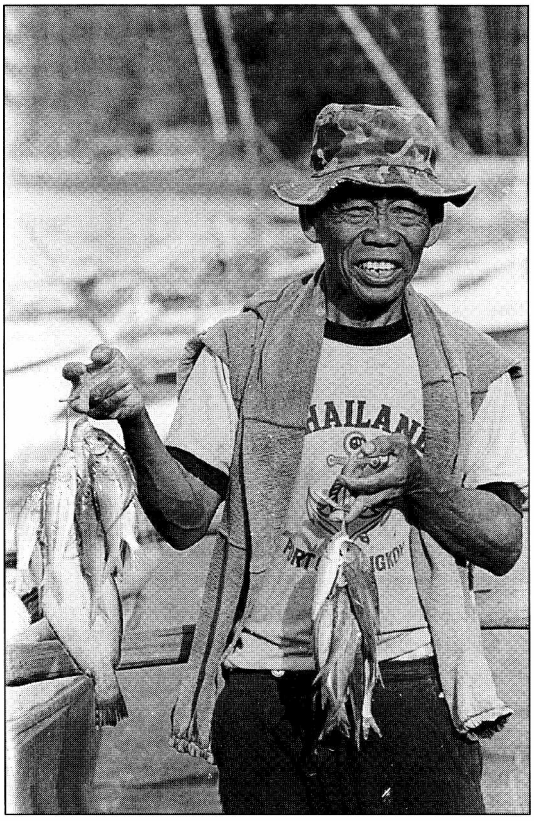
Year	Total	Capture fisheries				Aquaculture			
		Marine	%	Inland	%	Coastal	%	Fresh-water	%
1979	1,946.30	1,802.30	92.60	103.7	5.33	10.9	0.56	29.4	1.51
1980	1,989.01	1,756.90	88.57	110.4	6.16	60.1	3.36	34.5	1.92
1981	1,792.99	1,587.90	88.33	116.5	5.86	67.5	3.39	48.1	2.42
1982	2,120.10	1,949.70	91.96	87.7	4.14	36.9	1.74	45.8	2.16
1983	2,255.40	2,055.20	91.12	108.4	4.81	44.8	1.99	47.0	2.08
1984	2,134.80	1,911.50	89.54	111.4	5.22	61.5	2.88	50.4	2.36
1985	2,225.20	1,997.20	89.76	92.2	4.14	60.6	2.72	75.2	3.38
1986	2,536.30	2,309.50	91.06	98.4	3.88	39.1	1.54	89.3	3.52
1987	2,779.10	2,540.00	91.40	87.4	3.14	61.9	2.23	89.8	3.23
1988	2,629.70	2,337.20	88.88	81.5	3.10	108.9	4.14	102.1	3.88
1989	2,740.00	2,370.50	86.51	109.1	3.98	168.7	6.16	91.7	3.35
1990	2,786.40	2,362.20	84.77	127.2	4.57	193.2	6.93	103.8	3.73
1991	2,967.70	2,478.60	83.53	136.0	4.58	230.4	7.76	122.7	4.13
1992	3,239.80	2,736.40	84.46	132.0	4.07	229.3	7.08	142.1	4.39
1993	3,327.10	2,752.50	82.73	135.0	4.06	295.6	8.88	144.0	4.33

Source: Division of Fisheries Economic. Department of Fisheries, Thailand.

grove was destroyed for land settlement, shrimp farms, among others. This destruction has affected the spawning grounds of aquatic organisms. The wastewater discharges of industries, domestics, and aquaculture activities has been quoted as causing a deterioration in coastal natural resources and the environment.

The table above summarizes fisheries production in Thailand by caputre and culture.

References will be provided upon request.



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of coral reefs and wetlands, mangrove forests, as well as increasing erosion of the shore are evident. With the exception of one or two countries in Asia that have not ventured into large-scale aquaculture but have converted to other uses as well, mangrove degradation.

Reports say that attempts to form strategies for sustainable development have been hampered by defective knowledge of the nature and rate of degradation. This particular information is considered essential for a proper understanding of environmental problems. It is also necessary for the development of accurate intervention models for future environment change (Parnwell and Bryant 1997).

At least three international organizations have taken the lead to talk about the sustainability of aquaculture and on the encroachments on the margins of the sea. In 1997, a meeting to discuss the effects of the use of chemicals in aquaculture, especially those which appear likely to be hazardous to man, cultured stock, and the environment was organized by SEAFDEC/AQD, FAO Fishery Resources Division, CIDA's ASEAN Canada Fund and the World Health Organization. The findings of the meeting were discussed in the Joint Group of Experts on the Scientific Aspects of Marine Pollution. The need to synthesize and disseminate information on the use and management of "aquachemicals" has been recognized. The meeting prepared a set of guidelines to address major problem areas and possible solutions particularly intensification, fishhealth management and access to information, prophylactic use of antibacterials, and lack of data on the quantities of chemicals used. The role and responsibility of the government, the private sector, and the academe with regard to legal and institutional frameworks to govern chemical usage in aquaculture were also discussed and incorporated in the guidelines (SAA March 1997).